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Esq., M.A., and Charles James Buchanan Riddell, Esq., Lieut. in the Royal Artillery, were balloted for, and severally elected Fellows of the Society.

A paper was in part read, entitled, "Researches in Physical Geology:" Third Series. By William Hopkins, Esq., M.A., F.R.S.

January 20, 1842.

SIR JOHN WILLIAM LUBBOCK, Bart., V.P. and Treas.,
in the Chair.

His Majesty the King of Prussia was balloted for, and duly elected a Fellow of the Society.

John Tricker Conquest, M.D., and Francis Henry Ramsbotham, M.D., were severally balloted for, but not elected into the Society.

1. The reading of a paper, entitled, "Researches in Physical Geology:" Third Series. By William Hopkins, Esq., M.A., F.R.S., was resumed and concluded.

In a paper formerly read to the Society, the author had investigated an analytical expression for the precession of the pole of the earth, on the hypothesis of the earth's being composed of a heterogeneous solid shell inclosing a heterogeneous fluid; and showed that its amount, deduced from that hypothesis, could not agree with its actual observed amount, unless the ellipticity of the interior surface of the shell were less by a certain quantity than that of the exterior surface. As the ellipticity of the inner surface (assuming always that the earth was originally fluid) depends on the thickness of the shell, the author, in the present paper, determines the least thickness which can be deemed compatible with the observed amount of precession.

In his former communication, the author had contemplated only the case in which the transition from the solidity of the shell to the fluidity of the mass contained in it was immediate; but in the case of the earth it must be gradual and continuous. It is remarked, however, that if in the actual case we were to consider all that portion of the mass as solid which is not perfectly fluid, we should take the thickness of the shell too great; and, on the other hand, if we were to consider the whole of that as perfectly fluid which is not perfectly solid, we should take the thickness of the shell too small. There must, consequently, be some surface of equal fluidity, (or, if we please, of equal solidity,) such that if all above it were perfectly solid, and all beneath it perfectly fluid, the precession would be the same as in the case in which the transition from the solidity of the shell to the fluidity of the interior mass is continuous. This surface is termed by the author the *effective inner surface*; and the distance

between this surface and the outer one, the *effective thickness* of the shell.

The degree of solidity or fluidity at any point in the interior of the earth must depend partly on the temperature at that point, and may also depend partly on the pressure there. Both causes are here assumed to be effective: if the latter be not so, it will easily be seen that the conclusion arrived at will, *à fortiori*, be true.

If through any point in the interior of the earth, (as, for instance, a point in the axis of rotation,) we take a surface of equal temperature, and through the same point, a surface of equal pressure, it is evident that the surface of equal fluidity (or solidity) through that point must be intermediate to these two surfaces. Its exact position cannot be determined without an experimental knowledge, which we do not possess, of the relative effects of temperature in opposing, and of pressure in promoting the process of solidification. It is sufficient, however, for the purpose now in view, to know that it must necessarily lie between the surfaces of equal temperature and of equal pressure as its extreme limits; and of these the author proceeds to determine the position.

The forms of the isothermal surfaces within a spheroid have never been completely determined. The determination given by the author is an extremely approximate one when the ellipticity is small, and the time during which the process of cooling has been going on is very great, as it is presumed to be in the case of the earth.

The author then enters into the analytical investigation of this problem; and deduces the conclusion that we must descend to a depth greater than about one-fifth of the earth's radius before we arrive at a surface of equal fluidity (or solidity) having an ellipticity of the requisite value: that is, the effective thickness of the crust must be at least equal to one-fourth or one-fifth of the earth's radius, in order that the precession may have its observed value: a conclusion, the author observes, which entirely removes the foundation of certain vague and somewhat fanciful speculations in geology, proceeding on the hypothesis of the thickness of the earth's crust not being greater than twenty or thirty miles. It has been imagined that in active volcanos, the volcanic vent may communicate directly with the central fluid nucleus, whence the ejected fluid mass has been supposed to be derived. This notion, the author conceives, is rendered totally inadmissible, when it is proved that the thickness of the solid portion of the globe cannot be less than 800 or 1000 miles. It is also remarked, that it follows from the great thickness of the crust, that the present interior temperature of the earth cannot be due to its original heat unless pressure be effective in promoting solidification, a fact not yet established by experiment: for, if the present temperature be due to that cause, it is certain that it must be sufficient at the depth of probably less than fifty miles to reduce the matter composing the crust of the globe to a state of fusion under the atmospheric pressure; whereas it has been proved that the earth is solid to a very much greater depth; which can be account-

ed for, therefore, only by supposing its solidity to be preserved by the enormous pressure to which, at considerable depths, the mass is subjected. The author then offers an explanation of the phenomena of volcanos on the supposition that a portion of matter more fusible than the general mass of the globe exists in a state of fusion in subterranean reservoirs, forming so many subterranean lakes of determinate extent; in some cases originally distinct; in others, communicating with adjoining lakes, by more or less obstructed channels; a theory which will also account for all the obscure geological elevations, except perhaps the earliest, as being produced by a simultaneous action of a fluid pressure on every portion of the lower part of a solid mass of definite extent. The author considers this harmony in his general views with the results of analytical investigation as constituting for them a strong claim to the attention of geologists.

Another important conclusion which the author deduced from his researches is, that if the interior temperature of the earth be due to its primitive heat, pressure must be effective in promoting solidification of masses at high temperatures.

2. The following paper was read:—"Contributions to Terrestrial Magnetism," No. III. By Lieut.-Colonel Edward Sabine, R.A., F.R.S.

In this memoir, the author gives a detailed account of the observations on the magnetic intensity made at sea by the officers of the *Erebus* and the *Terror* on their passage from England to Kerguelen's Land; the unreduced observations transmitted to the Admiralty by the Commanders of these ships, Captain James Ross and Captain Crozier, having been placed in his hands for that purpose.

The first part of the paper relates to the observations made between England and the Cape of Good Hope; and the second, to those made between the Cape and Kerguelen's Land. These observations, made at various stations, are given in the form of tables; and their accordance with the isodynamic lines drawn from Mr. Dunlop's observations, contained in the first number of the author's contributions on this subject, is pointed out.

January 27, 1842.

SIR JOHN WILLIAM LUBBOCK, Bart., V.P. and Treas.,
in the Chair.

Samuel Peace Pratt, Esq., was balloted for, and duly elected a Fellow of the Society.

The following papers were read, viz.—

1. "Barometrical Observations made at Yarmouth, Norfolk, on